

Establishment of Permanent Sample Plots and Analysis of Stand Characteristics for Interior Douglas-Fir Forests

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ABSTRACTS In order to study the dynamics of uneven-aged stands of interior Douglas-fir, *Pseudotsuga menziesii* var. *glauca* (Mirb.) Franco in future, six permanent sample plots were set up on the Knife Creek Block of the Alex Fraser Research Forest of University of British Columbia. The measurements and observations for all living trees within the boundaries of a plot were made, including DBH(diameter at breast height), TTH(total tree height), height to lowest living branch, crown diameter, tree vigor, angle of lean, distance of lean, direction of lean and tree location. Based on the data, some stand characteristics of the plots were analyzed simply and preliminarily. Results showed that most of the interior trees on the plots are ranged 10-20 cm in distribution of DBH class, and 2-6 m in distribution of TTH class. Trees with different sizes, however, are distributed unevenly. The relationship between total tree height and diameter at breast height follows a quadratic distribution, $Y=a+bX+cX^2$.

Key word: Permanent sample plot, Stand analysis, Douglas-fir

INTRODUCTION

Douglas-fir(*Pseudotsuga menziesii* var. *glauca* (Mirb.) Franco) is a main timber tree species growing in the west coast and the north interior of B.C., Canada. Although some of the Douglas-fir trees may grow over 100 m in height on coastal sites, they may grow much smaller on interior sites than on coastal sites. To study the dynamics of uneven-aged stands of interior Douglas-fir, six permanent sample plots were installed on the Knife Creek Block of the Alex Fraser Research Forest of University of British Columbia, near Williams Lake, B.C. during June and July, 1988. And some stand characteristics of the plots were analyzed simply and preliminarily based on the data from the six plots. This only presented a initial understanding of a long-term project to study the growth of interior Douglas-fir forests. We greatly appreciate the contributions of Albert Nussbaum, Departmental Technician, for helping install the plots, and Ken Day, Resident Forester at the UBC/Alex Fraser Research Forest, for providing valuable on-site assistance which contributed greatly to our comfort and efficiency while we were in the field, without whom none of this research would have been possible.

ESTABLISHMENT OF PLOTS

Location of Plots

The plots were estab-

lished east of Pipeline Road and south of Jones Creek Road in the Knife Creek Block of the UBC/Alex Fraser Research Forest. This block is located approximately 15 km southeast of Williams Lake, B.C. Plot locations were selected following an extensive reconnaissance of the Knife Creek Block and an intensive reconnaissance of the area in which the plots were located. Plots 1 through 4 were established on a portion of an approximately 40hm² block partially harvested in 1983 according to the criteria subsequently documented by Armleder et al. (1986) for maintenance of mule deer winter range. There was also evidence of previous light logging probably for railway ties. Apportion of this block was spaced in 1984. Mule deer winter range habitat usage studies have been made on this block following the 1983 logging. Plot 5 and 6 were located in an adjacent block which was not harvested or spaced in 1983-84 and which has served as a control in the habitat usage studies. There was no evidence of previous harvesting in the area of the plots. Specific plot locations were selected to reflect as wide of diversity of stand density and structure as possible while still maintaining a mixture of different height and diameter classes within each plot. Plots 1 through 4 are 0.1hm² in size (31.6 m × 31.6 m) while plots 5 and 6 are 0.05hm² in size (31.6 m × 15.8 m) The smaller size of the latter two plots was necessary to maintain some degree of uniformity of conditions within the plots and to keep the number of trees measured to a manageable size.

Establishment of Plots

Plot boundaries were established using a hand-held compass and subsequently fine-tuned with a staff compass. Care was taken to ensure that the boundaries closed within acceptable tolerances. Boundary orientations were 52°-232° and 142°-322° for plots 1 through 4, and 360°-180° and 90°-270° for plots 5 and 6. Corners were marked with 122 cm × 5 cm × 5 cm wooden posts. Plot centre was located at the intersection of strung lines between opposite corners and also marked with a wooden post. The centres on certain plots are not exact due to obstructions from standing trees. All living trees greater than 1.3m in height which germinated within the plot boundaries were identified by a blue plastic tag. Tags were affixed to the trees with nails at breast height (1.3 m) when the trees were large enough in diameter to nail. Tags were wired to smaller diameter trees. Wired tags are not necessarily attached at breast height. All tagged trees on each plot were mapped by recording a distance and a bearing from the plot centre to the tree. Distances were measured using a nylon chain and recorded to the nearest 0.1m. Bearings were measured to the nearest degree using a staff compass set up at the centre stake (Fig. 1 and 2).

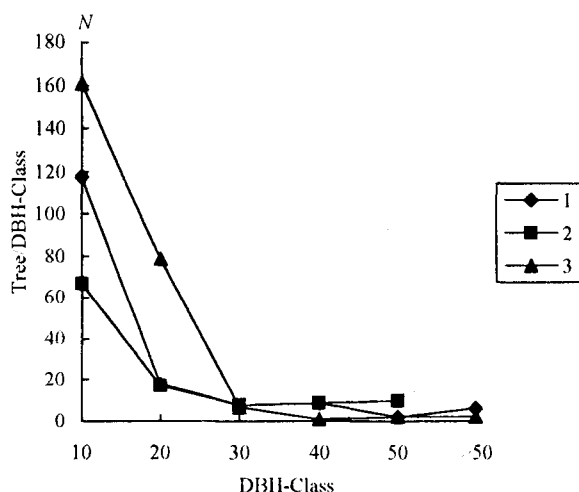


Fig. 1. Distribution of DBH (Plot 1, 2, 3)

Measurements of Plots

All living trees within the boundaries of a plot had the following measurements observations made:

Species - self explanatory.

Diameter at breast height

Measured using a diameter tape and recorded to the nearest 0.1cm. Measurements were made directly above the nail on all trees which were large enough to have tags attached by nails. Diameters on wired trees were measured only after determining breast height.

Total tree height

Measured using a height pole for shorter trees (< 8 m) and a suunto hypsometer

for taller trees. Height, measured with the height pole were recorded in the field to the nearest 0.1m. Heights requiring the use of a suunto were calculated from horizontal distance measurements (recorded to the nearest m), and percentage slopes to the top of the tree and breast height (recorded to the nearest percent). In order to facilitate accurate estimates of height growth, the bearing from the tree to the observer was recorded (to the nearest 10°) when the suunto was used.

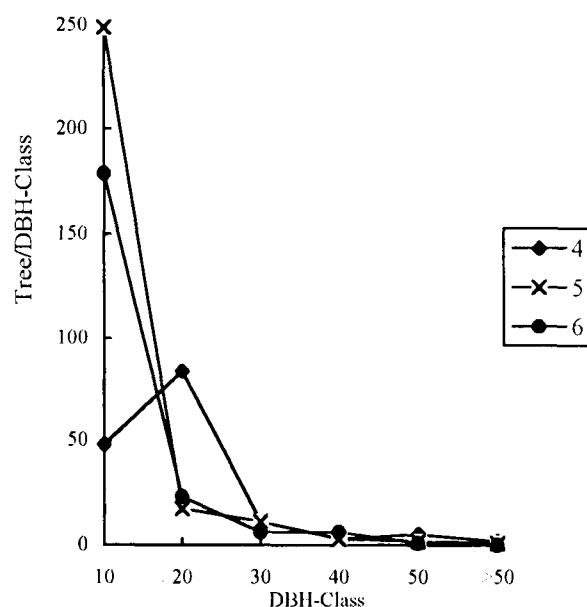


Fig. 2. Distribution of DBH (Plot 4, 5, 6)

Height to lowest living branch

Measured using a height pole (< 8m) or a suunto hypsometer. The lowest living branch was defined as the lowest, non-epicormic branch which could be located anywhere on the trees' circumference. This measurement was taken rather than height to live crown because of difficulty in defining where the live crown began in many of the larger Douglas-fir. Measurements made using the height pole were recorded in the field to the nearest 0.1m. Heights requiring the suunto were calculated from the horizontal distances (recorded to the nearest m) and percentage slopes to the lowest branch and to breast height (recorded to the nearest percent). These measurements were made from the same position as the measurements for determining tree height.

Crown diameter

Recorded to the nearest 0.5 m in two directions, parallel to the direction of the strip and at right angles to the strip. Strip direction was easily determined from the location of the tags. Crown edges were determined with a suunto for larger trees, and the distance between opposite edges measured with a cloth tape. Measurements of crown radii in each quar-

ter located with respect to the base of the tree would be useful for future crown mapping.

Tree vigor A subjective code assigned to each tree based on the quantity and quality of its foliage, the development of its crown, whether or not it was overtopped, etc. In short, the code was related to the observer's assessment of potential future development of the tree. Four classes were assigned: 0 indicated that the tree is dead; 1 indicated that the tree is alive, but has little potential for future growth (e.g., sparse foliage, badly overtopped, etc.); 2 indicated moderate potential (tree may be partially overtopped, the crown may not be fully developed, etc.); and 3 indicated good potential (foliage appears vigorous, good crown development, etc.).

Angle of lean Estimated to the nearest 5° from vertical for all trees in which the top was obviously at a different horizontal position than then base.

Distance of lean Horizontal displacement of the top of the tree from the base. Measured with a cloth tape and recorded to the nearest 0.5m. Direction of lean - bearing of the horizontal displacement of the top of the tree from the base. Measured with a silva compass and recorded to the nearest 10°.

Tree location the direction and distance of the point of germination of a tree from the centre stake was measured to the nearest degree using a staff compass. Distance was measured to the nearest 0.1m using a

cloth tape.

Species, DBH, total tree height and location were recorded for each border tree and for larger (i.e., >10cm) standing dead trees in each plot which appeared to have only recently died. If the tree was leaning, angle of lean was approximated, but distance and direction of lean were not recorded.

ANALYSIS OF STAND CHARACTERISTICS

In order to gain and file essential data in the growth of interior Douglas-fir trees on the six plots, some of the main factors of tree growth, such as DBH (Diameter at breast height), BA (Basal area), TTH (Total tree height) and MCW (Mean crown diameter) were calculated and analyzed for further study of future. The general overview of each plot is shown in Table 1.

Distribution of DBH The trees less than 10 cm in DBH are highest on each plot, except plot 4, which comes to 73.8% (118 trees) on plot 1, 57.3% (67 trees) on plot 2, 63.9% (161 trees) on plot 3, 88% (249 trees) on plot 5 and 83.3% (179 trees) on plot 6, respectively, while a large numbers of trees on plot 4 are ranged 10-20cm, accounting for 54.9% (84 trees). The trees greater than 50cm in DBH are lowest (less than 14%) on each plot (Fig. 1 and 2).

Table 1. Overview of the plots

Item		Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
Stems / hm ²		1600	1170	2520	1530	5660	4300
Plot Area (hm ²)		0.1	0.1	0.1	0.1	0.05	0.05
Trees / plot		160	117	252	153	283	215
DBH (cm)	Minimum	0.3	0.3	0.6	1.5	0.3	0.8
	Maximum.	87.8	79.6	67.0	54.6	51.7	48.0
	Mean	10.6	14.8	8.5	14.4	5.9	6.4
	Stad. Dev.	15.3	17.4	8.8	9.8	7.5	7.4
BA (cm ²)	Minimum	0.07	0.07	0.28	1.77	0.07	0.50
	Maximum.	6054.51	4976.41	3525.65	2341.40	2099.28	1809.56
	Mean	272.25	405.68	117.20	237.92	71.59	75.21
	Stad. Dev.	836.04	785.08	344.66	395.77	232.21	218.91
TTH (m)	Minimum.	1.40	1.40	1.40	1.20	1.40	0.60
	Maximum.	32.50	35.80	30.05	27.05	27.05	28.90
	Mean	8.08	10.31	7.75	12.22	5.52	5.88
	Stad. Dev.	7.92	9.59	5.70	5.42	4.93	5.17
MCW (m)	Minimum.	0.50	0.00	0.25	0.50	0.25	0.25
	Maximum	10.25	8.25	6.00	8.00	6.50	6.00
	Mean	2.52	2.87	2.15	2.99	1.37	1.80
	Stad. Dev.	1.85	1.91	1.36	1.31	1.01	1.24

Distribution of TTH The trees ranged 2 - 4 m in height are most on each plot, except plot 4, which is 34.4% (55 trees) on plot 1, 35% (41 trees) on plot 2,

26.2% (66 trees) on plot 3, 38.9% (110 trees) on plot and 35.8% (77 trees) on plot 6, respectively (Fig. 3, only show plot 1, others omitted).

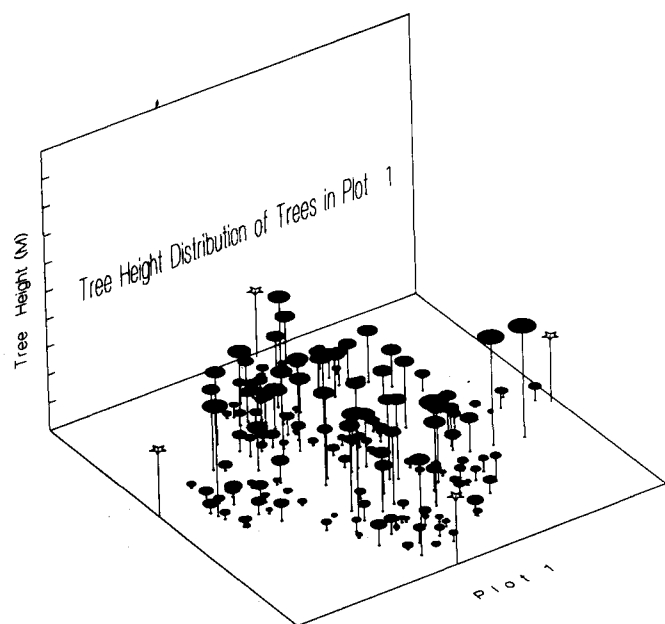


Fig. 3. Tree height distribution of trees in plot 1

Distribution of Crown

The smaller sized trees and stand densities are much higher on plot 3, 5 and 6 than on other three plots, so their crowns are far narrower and distributed evenly. Plot 1 and 2 have relatively large trees with wider crowns, but stand densities are lower, so distribution of crown is unevenly, forming quite open areas on forest ground. Probably, this is helpful to regenerate naturally and increase stand density in future (Fig. 4, only show plot 1, others omitted).

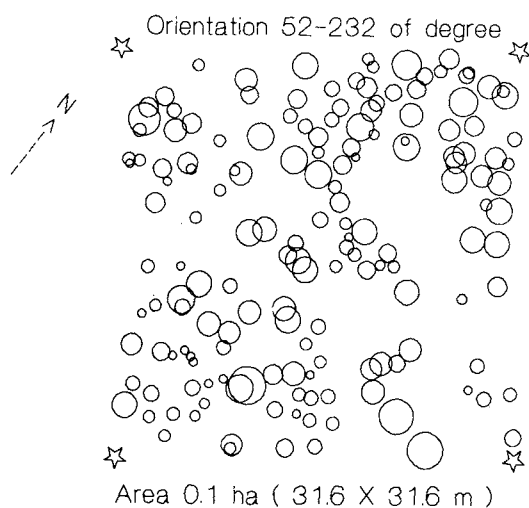


Fig. 3. Crown distribution of trees in plot 1

Characteristics of Relation between TTH and DBH

Based on the data of these plots, the rela-

tion between tree height and diameter at breast height follows a quadratic distribution, that is, $Y=a+bX+cX^2$, but not $Y=a+b/X+cX$. Whether separately using data from each plot, or using them together to simulate this relation, the results show the same, that is, the former is better than the later in Squared Multiple R. (Table 2).

Table 2. Comparison between the two models of TTH vs.

Model	DBH		
	No. of Trees	Plot	Squared Multiple R.
$Y=3.567-1.815/X+0.476X$	133	1	0.854
$Y=0.588+0.954X-0.007X^2$	133	1	0.964
$Y=2.822-1.139/X+0.532X$	72	2	0.946
$Y=0.695+0.875X-0.005X^2$	72	2	0.991
$Y=4.501-4.106/X+0.534X$	173	3	0.864
$Y=0.467+1.041X-0.011X^2$	173	3	0.952
$Y=7.785-13.484/X+0.455X^2$	105	4	0.858
$Y=0.289+1.11X-0.012X^2$	105	4	0.911
$Y=4.306-5.331/X+0.491X$	138	5	0.930
$Y=0.559+1.029X-0.011X^2$	138	5	0.970
$Y=3.433-4.285/X+0.617X$	120	6	0.896
$Y=0.316+1.064X-0.012X^2$	120	6	0.919

CONCLUSION AND DISCUSSION

The statistics and analysis above tell part of the story that for interior Douglas-fir trees on the plots, young trees, smaller ones in size, are prevailing in number, most of which are ranged

10-20 cm in distribution of DBH class, and 2-6 m in distribution of TTH class. This shows that the stands are on the stage from regeneration to succession. Trees with different sizes, however, are distributed unevenly. Plots 1 and 2 have relatively less trees/hm², but larger, while plots 5 and 6 relatively more but smaller. The relationship between total tree height and diameter at breast height follows a quadratic distribution, $Y = 0.695 + 0.875/X - 0.005X^2$, with Squared Multiple R of 0.991.

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